CHAPTER 22

PRESTRESSED CONCRETE BEAMS

Refer to Prestressed Concrete, in the **AASHTO Standard Specifications for Highway Bridges**. All concrete beams for bridges will be precast and prestressed by pre-tensioning. Post-tensioning may be justified for prestressing on a case-by-case basis.

Concrete with an f'_c = 5000 psi is normally used for prestressed concrete beams. An increase to 6000 psi or higher is permissible where it is reasonable to expect that this strength will be consistently obtained. Reinforcing steel meeting the requirements for AASHTO M31M, Grade 60, shall be specified. Normally, prestressing strands shall be high-strength 7-wire low-relaxation strand, with nominal ½ inch diameter, and conform to AASHTO M203, 270,000 psi grade, low-relaxation strands. Minimum strand spacing (center-to-center of strand) will be four times the nominal strand diameter.

Epoxy coating is not normally specified for prestressing strands, but may be justified in areas where flooding may inundate the bottom of the superstructure. On post-tensioned structures, the designer will specify that all strands will be uncoated and all strand conduits will be pressure-grouted. AASHTO, in conjunction with the Precast/Prestressed Concrete Institute (PCI), has developed several standard voided slabs, I and box sections commonly referred to as the AASHTO Girders or the PCI-AASHTO Standard Sections.

The District uses the following types of precast-prestressed concrete beams:

- Voided slabs
- AASHTO I-girders
- Adjacent box girders
- Spread box girders

The following Spacing for concrete beams are considered:

- Minimum, 7'- 6"
- Desirable, 8'- 6"
- Maximum, 9'- 6"

NOTE: These spacings do not apply to adjacent box girders. Where vertical clearance is not a problem, a wider spacing may be justified, on a case-by-case basis.

22.1 Voided slabs

The AASHTO voided slab is commonly used for short spans varying from 30 to 50 ft.

22.2 AASHTO I-Girders

The AASHTO I-Girders are generally used for short to intermediate spans. AASHTO I-girders can be modified to accommodate longer spans.

22.3 Adjacent and Spread Box Girders

For spans greater than 50 ft. AASHTO has also developed a series of standard box sections.

22.4 Composite Design

Composite flexural members consist of cast-in-place concrete elements constructed in separate placements but so interconnected that all elements respond to superimposed loads and live loads as a unit. The entire composite member may be used in resisting shear and moment.

22.5 Cast-in-Place Deck Slabs

Generally designed to provide composite action with concrete box or I-girders. The use of composite designs must be noted under General Notes on the plans for future reference.

22.6 Continuity for Live Load

Prestressed concrete beams will be designed as simply supported for dead load and continuous for live load and impact. Continuity is attained by additional reinforcing steel in the deck over beam joints and with poured reinforced diaphragms at the beam joints.

22.7 Diaphragms

The end diaphragms for each span on skewed bridges must also be skewed. Intermediate diaphragms are perpendicular to the beams. Diaphragms are poured and cured prior to pouring the deck. The minimum number of diaphragms is three per span, one at each end and one at midspan.

22.8 Strands

Standard AASHTO drawings for prestressed concrete I-Beams and Box Beams will be used. Complete details, including the prestressed strand pattern and bearing details shall be shown in the contract plans for each bridge. Drilling for inserts into prestressed concrete beams will not be permitted. For any pre-tensioning application, ½ in. diameter strands, at a spacing of 1 ¾ in. shall be used. Also, the use of 0.6 in. diameter strands, at a spacing of 2 in., is permitted.

Each strand shall be given an initial tension of 0.75 f's A_s* as specified in applicable sections of the current edition of the PCI Design Handbook - Precast and Prestressed Concrete. Seven-wire prestressing strands shall conform to AASHTO M203M (ASTM A416), Grade 270 and shall be low relaxation strands. Shipping and handling stresses shall be considered when designing prestressed concrete beams. This is especially important for long span members (over 130 ft.) with slender webs and small flanges.

22.8.1 Adjacent Voided Slab and Box Beam Design

It is recommended that adjacent slab and box beams not be utilized for bridges with skew angles greater than 30 degrees. Prestressed concrete box beam bridges shall utilize 48 in. wide box beams whenever possible. All efforts should be made to avoid a mixture of 48 in. and 36 in. wide box beams in satisfying geometrical constraints. Prestressed concrete adjacent slab and box beams shall be surmounted with a minimum 4 in. thick concrete deck slab designed for composite action. Reinforcement steel shall be #5 @ 12 in. centers, both directions, with 2½ in. cover and shall be corrosion protected. That is, epoxy coated or galvanized reinforcement shall be used.

Non-composite design (but with composite details and construction) should also be considered. The Construction Specifications allow a tolerance of plus/minus ¼ in. in the width of box beams. Abutment seats shall be detailed of sufficient length to accommodate this possible dimensional overrun in a group of beams. Abutment seats may be sloped in the transverse direction to conform with the deck cross slope, however, bearing seats shall generally be set level in the longitudinal direction parallel to the direction of the beams. If the bearing seats are not set level in this direction, gravity loads will cause shear in the elastomer. The use of a tapered sole plate or tapered grout pad may be required so that the bearing surfaces are set level to avoid imposing excessive rotation and the resulting stresses in the bearing.

22.8.2 Transverse Ties and Keyway Grouting

Transverse ties shall be high tensile strength steel bars conforming to AASHTO M275M (ASTM A722). Bars should preferably be 1 in. in diameter; however, bars up to 1 3/8 in. in diameter may be used, if necessary. ½ in. in diameter, 270 KSC strands may also be used as transverse ties. The end anchorage shall be protected from corrosion in accordance with DDOT standards.

Generally rods are preferred over strands for transverse ties because the end anchorage details are less complicated. If prestressing strands are utilized as transverse ties instead of high strength rods, more than one 7-wire strand may be utilized per transverse duct, if necessary.

22.8.3 Epoxy Waterproofing Seal Coat Limits

Prestressed concrete beams shall be treated with an epoxy waterproofing seal coat conforming to DDOT standards. The limits for sealer application shall be shown on the construction plans and shall conform to the following Table:

Table 22-A

Beam Type	Areas to be Treated	Application Limits
I-beams	Ends, sides, bottoms	48 in. length from the beam and end for exterior surfaces and 48 in. length from the beam end for interior surfaces
Box-Beams	Ends, bottoms	48 in. length at the ends of channel beams and exterior face beams subject to deck joint voided slabs of fascia beams leakage.

Epoxy waterproofing seal coating is not required for diaphragm connection areas. As per bearing manufacturer's recommendations, epoxy waterproofing shall be omitted from the bearing contact area. This requirement shall be reviewed. For continuous bridges, epoxy waterproofing seal coat shall be applied only to the beam-ends located under or near deck joints.

NOTE: Refer to the **Structural** chapter within this manual; this is applicable to all reinforced structures

22.9 Camber

Beams must be cambered in the fabrication process. A camber diagram is needed for proper fabrication of the beam and must be included in the bridge plans. Camber deflections should be computed for each beam at the midpoint of each span. The designer should furnish camber deflections for the following:

- The estimated pre-stress camber loss due to the dead load of the beam at the time of installation multiplied by a creep factor.
- The deflection due to dead load of the slab and parapet.
- Deduct the positive deflection due to prestress.
- The final net camber, which is the combination of the first three.

The above are theoretical values and may vary with actual concrete strength (age), various pre-stressing conditions, creep and pre-stress loss. No creep factor is assumed in calculating dead load deflection for the slab and parapet. Creep of concrete is the time-dependent deformation of concrete under a sustained load. In developing camber diagrams, the designer should consider the differences in loadings, such as the effects of sidewalks, parapets, and barriers, on individual beams and girders.

The deflections caused by the dead load from the concrete girders, forms, and reinforced concrete deck, are resisted by the concrete superstructure. Deflections caused by superimposed dead load are resisted by the composite section, comprised of the reinforced concrete deck and the beams. The fascia beam likely will not deflect the same as interior beams. Consequently, a camber diagram must be provided for fascia beams as well as for interior beams. Because the screed rail for the deck-finishing machine is set from the fascia beam, camber of the fascia beam is critical to achieve the correct deck elevations, the specified deck thickness and proper drainage.

Because of the potential hazard from ponding and freezing of water on the deck, the designer must evaluate beam deflections, deck cross slope and roadway geometry as well as scupper locations to ensure that water drains properly.